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FOREST INSECT INVESTIGATIONS

FOREST INSECT CONDITIONS IN THE YELLOWSTONE NATIONAL PARK DURING THE SEASON OF 1926

By
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OUTLINE

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INTRODUCTION

The writer spent the period June 12th to September 15th in the Yellowstone National Park investigating insects injurious to forest trees. As in 1925, headquarters were established at the Riverside Ranger Station near West Yellowstone, Montana, because this location is in the area defoliated by the lodgepole needletyer and the lodgepole sawfly, and close to the highway areas sprayed for the control of these pests. Trips were made to Madison Junction, Fountain, Old Faithful, Thumb, Lake, Fishing Bridge, Sylvan Pass, Mud Geysers, Canyon, Dunraven Pass, Camp Roosevelt, Crescent Hill, Mammoth and the Grayling Creek Snowshoe Cabin. Trips were also made to forest areas near Henry's Lake, Basin Ranger Station and the timbersale areas in the Madison National Forest which adjoins the Yellowstone on the west.

All of the work was conducted in close cooperation with the National Park Service and the Forest Service. Park Ranger Arthur Jacobson assisted materially in numerous ways during the entire season. Assistant Chief Ranger, Joseph Douglas, directed the control work against the bark beetles. Superintendent H.M.Albright offered every facility for the work and took special interest in the investigations made. Forest Rangers W.W. Larsen and Verne Edwards accompanied the writer on the trips made in the Madison Forest and Forest Supervisor Derrick offered every assistance in his power.

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1. See Evenden, Defoliation of Timber Stands within the Yellowstone National Park, October 5, 1923.
   Forest Insect Problems of the Yellowstone National Park, October 22, 1924.
   Burke, Forest Insect Conditions in the Yellowstone National Park During the Season of 1925, March 16, 1926.

SUMMARY OF GENERAL CONDITIONS FOUND

On the whole it may be said that forest insect conditions in the Yellowstone appeared more favorable during 1926 than for several years past. The epidemic infestations of the spruce budworm and the lodgepole sawfly have disappeared and the lodgepole needletyer, working by itself, appears unable to kill trees.

Defoliators.

In the vicinity of West Yellowstone the lodgepole sawfly, Neodiprion sp., failed to appear in any numbers. A few eggs were laid but these did not hatch and no caterpillars were seen. The needletyer, Eulia sp., moths appeared in great numbers and many eggs were laid. These hatched into caterpillars and considerable defoliation occurred, especially in the Madison National Forest a few miles west of the Park Boundary. Practically all of the trees defoliated last year produced new foliage, however, and apparently few trees have died since 1924.

The spruce budworm, Cacoecia fumiferana, Clem., which several years ago killed numerous Douglas fir along the lower Yellowstone River between Camp Roosevelt and Blacktail Deer Creek failed to appear this year and the epidemic appears to have subsided. Many of the defoliated trees, however, are still dying from subsequent attacks by the Douglas fir beetle, Dendroctonus pseudotsugae, Hopk.

Barkbeetles.

The Douglas fir beetle, Dendroctonus pseudotsugae, Hopk., has continued to kill numerous Douglas fir in the budworm defoliated areas at the foot of Crescent Hill. It also killed a group of trees at Camp Roosevelt and several small groups of trees on both sides of the Yellowstone River in the vicinity of Tower Falls.

The mountain pine beetle, D. monticolae Hopk. killed a few white bark pine in the vicinity of Dunraven Pass and a number of lodgepole and white bark pine along the Sylvan Pass road on both sides of Sylvan Pass. The control work conducted at Dunraven Pass appeared very successful.

The Engelmann spruce beetle, D. englemann/Hopk., killed several Engelmann spruce at Cub Creek and some trees near the Grayling Creek Snowshoe Cabin.

The lodgepole pine beetle, D. murrayanae Hopk., attacked a number of living lodgepole pine in the vicinity of West Yellowstone, Mont. Apparently no serious damage resulted from the attack unless the tree was also attacked by the Oregon engraver beetle.

The Oregon engraver beetle, Ips oregoni, Eich., killed a number of lodgepole pine in the vicinity of West Yellowstone, Mont. Many of these trees were in the needletyer defoliated areas but some of them were in areas

where the defoliations had been very slight. Usually, in the latter case, the trees had been previously attacked at the base by the lodgepole pine beetle. The Oregon engraver beetle also continued to kill some trees in the various tourist camp grounds and on the geyser formation areas as it did in 1925. All of the control work conducted during 1925, except that at the Mud Geysers near the Lake-Canyon road brought about very satisfactory reductions in infestation. The work at the Mud Geysers caused some reduction but there still is considerable infestation.

The fir beetle, Dryocoetes confusus Sw., continued its activities in the Alpine fir in the vicinity of Sylvan Pass. Numerous trees died during the past summer and all were infested by Dryocoetes confusus. The infestation along the Canyon Junction-Dunraven Pass road appears to be disappearing as very few dying trees were found.

Barkweevils.

For the first time two of the bark weevils appeared in the Yellowstone as destroyers of timber.

The lodgepole pine barkweevil, Pissodes murrayanae Hopk., killed a number of scattered small lodgepole in the vicinity of West Yellowstone, Mont. Trees of from 1½ in. to 3 in. in diameter were attacked at the base. The work was also found in an 8 inch tree near Sylvan Pass.

The alpine fir bark weevil, Pissodes burkei Hopk., attacked a number of the larger firs, 12 to 24 inches in diameter, in the vicinity of Sylvan Pass. It attacks the inner bark of the main trunk and does considerable damage, being one of the species involved in the death of numerous trees in the Sylvan Pass area. It was also found infesting a top-broken, dying tree three miles west of Madison Junction.

THE LODGEPOLE NEEDLETYER AND THE LODGEPOLE SAWFLY.

Amount of Damage Caused.

Although there was considerable defoliation during the 1926 season in certain lodgepole pine areas within the National Park boundaries, most of it was not serious enough to cause the death of any trees. The principal infestations have moved west into townships 13 S, R. 44 and 45 E, two to five miles west of the National Park Boundary in the Madison National Forest. The defoliations in this area appear to be serious and many trees may die. The trees, however, undoubtedly are able to withstand heavy needletyer defoliation and most of them probably will recover if climatic conditions are favorable to tree growth for the next few years. No needletyer work was noticed outside of the Madison Basin which indicates that the general area infested during the past few years has not enlarged.

Very few sawflies were found and no defoliation by this pest was seen. a few caterpillars from the 1924 brood still remain in cocoons in the ground. These may produce some sawflies in the spring of 1927 but hardly enough to cause any serious damage.

Location of Heavily Defoliated Areas.

The areas heavily defoliated in 1926 are located in sections 16,17 18, 19, 20, 21, of T 13 S. R. 45 E. and sections 11,12,13,14, of T 13 S.R. 44 E.

Host plants.

Although the lodgepole pine (Pinus murrayana ~~Sieb~~ Balf. Balf.) is the principal host plant of the needletyer and the sawfly, both infest the white bark pine (Pinus albicaulis Engelm.) to a very limited extent.

Life History and Habits of the Needletyer.

During 1926 the moths emerged from the chrysalids in the needles on the ground between May 15th and June 19th. There was a heavy flight of moths on May 28th and they were fairly numerous until June 17th. Eggs were found in the field from May 28th until June 23, occuring in fair numbers until the 16th. The first evidence of hatching in the field was noted June 15th. Few hatched eggs could be found until June 28th. On July 2nd half of the eggs found had hatched; on July 5th 90% had hatched, and by July 7 no unhatched eggs could be found.

On June 15th, the first entrance hole into a needle made by a young caterpillar was found. The second was not found until the 22nd. By June 28th entrance holes were common; by the 30th numerous. On July 26th there were still a few caterpillars in the needles, but many of them had left and were forming tubes. By August practically all were in the tubes, only a few scattering specimens being found in the needles.

The first tube of tied needles was found July 12th. By July 20th tubes were common, and on August 5th most of the caterpillars were found to be in tubes. As many as twelve needles were found tied together to form one tube. By this time the parts of the needles which had been skeletonized were turning greenish white and could easily be detected. On August 21st some trees had most of the needles tied together in tubes, (Fig. B, pl.1) which were turning brown. On this same date many fullgrown caterpillars were found. These could still be found in numbers in the tubes on September 6th, but became scarcer by the 10th and practically all had left on the 16th.

The first caterpillar in the needles on the ground looking for a place to form a chrysalis was found August 27th. On September 10th caterpillars on the ground were common and a few chrysalids had formed. By September 13th 95% of the caterpillars had formed chrysalids. A few caterpillars could still be found as late as September 16th but by the 28th all had gone to the ground and were chrysalids.

From 29 chrysalids collected during September and taken to the laboratory at Palo Alto, Calif., 17 moths emerged during November. The other 12 appeared dead on December 31st. Twenty-six chrysalids collected in the field by Ranger Jacobson on January 10th appeared perfectly normal. Two weeks under laboratory conditions caused 5 to transform to moths. Higher temperature appears to be the factor that caused these chrysalids to produce moths at least six months before their normal time for emergence.

The moth emerges from the chrysalis by giving a few convulsive movements of the legs and body which causes the chrysalis to split in the region of the legs and down the ~~front part~~ anterior end of the back. Through this opening it emerges and crawls out of the ground cover to the surface. Resting awhile until the wings become fully spread and hardened, it then flies to the foliage of the pine.

The flight is rather slow and wavering or jumpy. It may occur at any time of the day and even during stormy weather but is more apt to take place during warm periods. Once on the foliage the moth usually rests rather quietly on a twig, a bud, or a needle, with the wings folded roof-like over the body. Any disturbance will cause it to wriggle down through the needles and drop to the ground, or to fly away to another twig or another tree or to the ground.

Mating takes place on the needles with the male and female facing in opposite directions and the tips of the abdomens touching. The wings of the female almost completely cover the male.

The coloration is protedtive, the alternation of light and dark brown color causing the moths to resemble the unopened buds of the lodgepole pine which occur at the time the moths are present.

Egg laying takes place on the concave side of a needle with the moth facing toward the tip. The eggs (fig. A, pl.1) usually are laid in two overlapping rows but sometimes there are three. The number of eggs in a group varies from 2 to 30; the average for 214 groups being 103 eggs to the group.

When first laid the eggs are almost the color of the needles and transparent. In a few days they become a brownish yellow and later with dark centers and yellowish rims. Just before hatching they get purplish gray and the young caterpillar within may be seen through the shell. Hatching takes place about seven to ten days after the egg is laid.

To hatch the caterpillar moves around and bites a slit in the shell along the sides where the rounded top joins the flat bottom. As soon as the slit is long enough the larvae pushes its head through and by various contortations crawls out of the shell and away on the needle. An entire group of eggs will hatch in from five to ten minutes.

The young caterpillar is a vigorous crawler and is perfectly able to go from needle to needle or from twig to twig. It enters a needle on the concave side about one fourth of an inch from the tip by biting a circular hole through the needle surface with its strong jaws. This entrance hole is marked by a mass of light greenish borings.

The caterpillar spends from two to three weeks in the needle mining out all or part of the interior. The tip usually is mined first and then the part toward the base. At least one other hole besides the entrance is made in the needle surface on the same side of the needle as the entrance. Usually, this is made toward the tip. The mine inside of the needle forms a tube which occupies the entire interior part of the needle. The tube is lined with a papery, white, closely woven web.

As soon as a caterpillar is through with one needle which may be after it has minded out a third, a half or the whole of it, it reaches out and by spinning a web draws together two or more needles to form a tube. This tube is also lined with a papery, white web. Usually there is an opening at the upper end and also one at the lower so that the caterpillar can leave the tube quickly if it is disturbed. It can wriggle rapidly down through the needles and will hang down on a long strand of web to escape.

Feeding takes place within the tube; the inner parts of the needles being eaten. As the caterpillar becomes larger the tube extends further down the needles, sometimes to the base. Other needles are drawn to those already used and the tube is enlarged to include as many as twelve or fourteen needles. Usually the more needles in the tube the less each needle is eaten. The first tubes are formed from the needles of the preceding years growth; the later ones from the new growth. Often a caterpillar will abandon one tube and form another.

After six to eight weeks spent in the tubes the caterpillar becomes full grown and drops to the ground by a strand of web. Then, crawling down into the mat of needles, it spins a very loosely woven cocoon, forming in this its chrysalis. The cocoon is attached to the old needles, old cones or other debris which goes to make up the forest floor. In from three to five days after the cocoon is spun the chrysalis is formed and the insect is prepared to spend the winter.

Life History and Habits of the Sawfly.

On June 13th a few needles were found with groups of new eggs in them. Most of these groups, or rows, started with an incomplete pocket and then contained from 2 to 14 complete pockets each with a single egg in it. Seven eggs was the average number found in the 27 infested needles collected. None of these eggs hatched. But a single group of caterpillars was seen on the foliage during the entire season. Also only one adult sawfly was found during the same time. This was collected June 17th while it wasresting on the foliage of a lodgepole pine. During the season of 1925 thousands of adults occured on the foliage of the lodgepole in the same locality.

During July, August, and September, cocoons, apparently from the 1924 brood of caterpillars, were collected from the fallen needles under the trees. A few of these contained healthy looking prepupal caterpillars but many were parasitized. Two taken to the Palo Alto laboratory produced male sawflies in January 1927. These observations indicate that some sawflies will emerge and lay eggs in the spring of 1927. Whether they will be in sufficient numbers to cause any noticeable defoliation cannot be foretold.

Control Work.

Spraying to prevent defoliation of the lodgepole pine between West Yellowstone and the Madison River Bridge started June 26th and was completed July 10th. A strip of timber from 150 to 200 feet wide on ~~each~~ either side of about ten miles of main and lateral highway was sprayed. 3800 pounds of powdered arsenate of lead, 140 gallons of fish oil and 60,800 gallons of water ~~was~~ were used. The work was done with a Fitzhenry-Guptil motor truck sprayer, an 800 gallon motor truck water carrier and a crew of ten men. The work was very successful, there being no noticeable defoliation of the trees sprayed.

Parasites.

Very few parasites of the needletyer and the sawfly were found during 1926. Two cocoons of the sawfly contained numerous larvae of a small wasp like parasite probably belonging to the family Chalcididae and two contained single larva of a parasite belonging to the family Ichneumonidae. None of the paper white cocoons of the Braconid parasite of the needletyer found in 1925 were seen during the summer of 1926. Ranger Jacobson, however, collected two among the needles on the ground in January 1927.

THE SPRUCE BUDWORM

So far as could be determined the Spruce Budworm has disappeared from the Douglas fir forests of the Yellowstone Park. Numerous trees are dying from the effects of past defoliations and the succeeding bark beetle infestations. This condition probably will continue for several years.

THE DOUGLAS FIR BEETLE

The Douglas fir beetle continued to kill numerous trees in the budworm defoliated areas. Scattering infested trees were also seen in areas adjoining the budworm areas. There was no new infestation in the area 16 miles east of Mammoth which was reported in 1925. A group of 21 trees on the hillside back of Camp Roosevelt and one large tree at the lower public camp at Tower Falls were found infested. One group of reddish trees was seen on the northside of the Yellowstone River across from Tower Falls and another group south of the River above Tower Falls.

At the request of Supervisor Derrick and Ranger Larsen, Douglas fir areas near Henry's Lake, Idaho, and the Basin Ranger Station, Montana, were examined. Many dead trees were found in both of these areas. Some showed the work of the Douglas fir beetle but some appeared to have died from other causes. The general impression received was that the death of the trees was not due to bark beetle infestation. Neither was any evidence found that the spruce budworm had caused any defoliation.

THE MOUNTAIN PINE BEETLE.

The mountain pine beetle infestation in lodgepole and in white bark pine in the Sylvan Pass country continued about the same as in 1925. Numbers of infested dying trees occurred at Cub Creek and other points along the highway but there was no evidence of a decided increase or of a decided decrease.

At Dunraven Pass where control work was carried on during the spring of 1926 there was a decided decrease, only four infested trees being found in the area where seventy-five were treated.

Five or six years ago the mountain pine beetle killed numerous lodgepole in what are now timber sale areas of the Madison National Forest about six miles southwest of West Yellowstone. There are numerous large dead black top trees with the old galleries and larval mines of the beetle plainly showing on the wood and in the bark. No evidence of recent infestation could be found.

All of the observations made indicate that there is but a single generation of the mountain pine beetle each year in the Yellowstone region. The broods that passed the winter of 1925 under the bark were ready to emerge on July 21, 1926. By September 11th these had attacked new trees and had produced eggs and small larvae. There was some overlapping of generations, however, since on this same date some trees were infested with a brood of prepupal larvae, pupae and young beetles.

THE ENGELMANN SPRUCE BEETLE.

This species which killed numerous trees in the area east of Yellowstone Lake several years ago, infested and killed a few trees again this year. Several infested dying trees were found at Cub Creek on the Sylvan Pass Highway and a few at the Grayling Creek Snowshoe Cabin on the Bozeman Highway.

The Grayling Creek infestation appeared to be caused by the damming and subsequent overflow of Grayling Creek which created unfavorable conditions for the Engelmann spruce.

The broods appeared to be mostly in the young beetle stage about September 15. Woodpeckers had stripped most of the bark off of one tree at Grayling Creek and had destroyed a large part of the brood.

THE LODGEPOLE PINE BEETLE

This rather secondary species attacked a number of lodgepole along the western boundary of the Yellowstone National Park in the vicinity of West Yellowstone. The beetles appear to have been attracted to this locality by the building of the boundary fence out of unpeeled lodgepole logs or poles. Numerous trees were attacked at the base. Short galleries were made through the bark and large masses of pitch mixed with reddish borings were thrown out at the entrances to these galleries. Nothing further happened to the tree and the attack failed unless the tree was subsequently attacked by the Oregon engraver beetle.

Parent beetles and eggs were found on July 15 and young beetles on August 19th.

THE OREGON ENGRAVER BEETLE

This supposedly secondary insect, which in the past has been the principal cause of the death of numerous trees around the geyser formations and in the camp grounds, appeared this year in the vicinity of West Yellowstone. Numerous dying lodgepole, both inside and outside of the defoliated areas, were found infested with the developing broods. (fig. C, pl. 1)

The greatest damage done outside of the defoliated areas was done along the boundary where the boundary fence was constructed of unpeeled lodgepole poles. The beetles attacked the poles and also the surrounding live trees some of which had been previously attacked at the base by the lodgepole pine beetle. Of ten trees to which 336 feet of fence was attached, 2 were attacked by the lodgepole pine beetle only, 4 were attacked by the Oregon engraver beetle only, 3 were attacked by both species and one was unattacked. Only the trees attacked by the Oregon engraver beetle died. Of the 12 trees within 7 feet of the fence, 2 were attacked by the lodgepole pine beetle and 1 by both species. Scattering, dying, infested trees occurred throughout the adjacent forest.

One tree girdled by a guy wire from a telephone pole, several trees scorched by fires, and a number of felled trees were found infested.

In some sections of the defoliated areas as many as 25 trees to the acre were found infested. Many of these trees were recovering from the efforts of the defoliation when attacked and killed by the beetles.

The species was found killing some trees in most of the camp areas and on the geyser formations but the control work conducted before the season opened caused considerable reduction at all points except the Mud Geysers on the Canyon-Lake Junction highway.

That the species will attack live trees was well illustrated by one tree found at West Yellowstone. One side of this tree was attacked several years ago. The brood developed and emerged and the tree continues to live and apparently has recovered from the attack.

The Oregon engraver beetle has two complete generations a year. Beetles that overwintered under the bark of trees killed in the fall of 1925 emerged during May and June 1926 and attacked live trees. Beetles developed from eggs laid by these emerged during August and attacked other trees and the brood of the latter (August brood) will emerge in May or June, 1927.

Associated with the Oregon engraver beetle, especially in some of the smaller trees, was found the lodgepole wood engraver beetle, Pityogenes knechteli Sw.

THE FIR BEETLE

The fir beetle continued to infest groups of dying alpine fir along both sides of the highway between Cub Creek and the East Entrance. Apparently there has been no special increase, about the same number of trees dying this year as last.

Associated with the fir beetle in the bark of some of the dying trees ~~was~~ were found the alpine fir weevil and several smaller bark beetles, Pityokteines minutus Sw. and Pityphthorus sp.

Apparently the fir beetle has one generation a year, overwintering as parent adults and larvae.

Besides alpine fir it will infest lodgepole pine under some conditions. During the winter of 1925 a log cabin was built of Alpine fir and lodgepole logs just west of Sylvan Pass. September 3, 1926, some of these logs were infested by broods of the fir beetle. At least one of these was lodgepole pine.

THE LODGEPOLE PINE BARKWEEVIL.

A number of small dying lodgepole, 1½ inches to 3 inches in diameter were found in the vicinity of the Riverside Ranger Station during the last of August 1926. These did not occur in groups but were scattered through the forest. Practically all of them were in the open and were not dying from suppression. Most of them were in areas where there had been some defoliation.

At the bases of all of these trees were broods (a, b, c, fig. A, fig. B, pl. 2) of the lodgepole pine bark weevil; most of which were in the fullgrown larval stage in shredded wood cocoons in the surface of the wood. Some of the cocoons contained pupae and some young weevils. The larvae soon pupated and transformed to beetles which emerged during September.

Some of the trees attacked and killed ~~and~~ had healthy looking green foliage even though the inner bark of the lower trunk and some of the roots was a riddled mass of borings. Therefore, it seems certain that the death of the tree is due to the attack of the weevil.

Most of the trees dying from the attack of the barkweevil contained broods of a smaller weevil in the upper trunk. This species was in the larval stage in small circular tunnels in the outer wood. (Fig. C, pl. 1). Some transformed to beetles later and proved to be a species of Cylindrocopturus. Sections of infested wood taken to the Palo Alto Laboratory produced numerous beetles and wasp-like parasites in December 1926 and January 1927.

THE ALPINE FIR BARKWEEVIL

Associated with the fir beetle in the dying alpine fir in the Sylvan Pass area, and sometimes working independently in injured timber in other sections of the Yellowstone, is this large, dark, grayish weevil. The eggs are laid in the cambium of the main trunk through a hole knawed through the bark by the mother weevil. As soon as they hatch the larvae mine up and down through the cambium until they become full grown. Each

then forms a cell in the surface of the outer wood, or the inner bark, in which it pupates and transforms to a young weevil. (Fig. C.D. pl.2) A cover of shredded borings is formed for each cell. Four to eight winding mines radiating from a common center is very characteristic of the work of this species.

The eggs of the fir weevil are laid in July. Some of the larvae have finished feeding and are in the pupal cells by the end of August. All are thus located by the end of September. The winter is passed as a larva in the pupal cell. Pupation takes place the next June and the transformation to the young weevil in July. Seven to ten days after transformation the young weevil knaws its way through the bark and emerges.

Apparently all of the weevils leave the infested tree by the first of August and feed on the bark of living fir twigs. They then seek dying or injured trees where mating takes place and the eggs are laid. A tree once infested may be reinfested if there remains any greenish bark on the trunk.

Besides the infestation in the Sylvan Pass area an infestation of this species was found in a top-broken tree near Madison Junction.

DYING TREES AROUND GEYSER FORMATIONS AND IN CAMP GROUNDS.

During the season of 1926 insects continued to cause the death of numerous trees around the geyser formations and in the various camp grounds. The control work conducted during the winter of 1925 can be considered very successful since it brought substantial reductions in the infestation in every case except one. The following conditions were found on an examination made during the first half of September.

Old Faithful Public Camp. Thirty lodgepole pine infested with the Oregon engraver beetle. No control work done in 1925.

Thumb Public Camp. Thirty-five infested lodgepole. About two hundred trees treated at various times in 1925.

Lake Public Camp. Eight infested lodgepole. Sixty-eight trees treated in 1925.

Fishing Bridge Camp. Ten infested lodgepole. One hundred eighty-two trees treated in 1925.

Mud Volcanoes. One hundred and fifty infested lodgepole. Five hundred trees treated in 1925.

Dunraven Pass. Four white bark pine infested with mountain pine beetle. Seventy five trees treated in 1925.

Tower Falls Lower Camp. One large Douglas fir infested with Douglas fir beetle.

Camp Roosevelt. Twenty-one infested Douglas fir. No control work in 1925. Control work in 1924.

Roaring Mountain. No infestation found. One hundred and fifty trees treated in 1925.

Cub Creek. General infestation in all species of trees. Mountain pine beetle in lodgepole and white bark pine. Fir beetle in alpine fir. Engelmann spruce beetle in Engelmann spruce. Groups of dying trees scattered throughout forest. No control work in 1925.

Sylvan Pass. Conditions same as at Cub Creek. Dying trees found from Cub Creek through pass to East Entrance of Park. Alpine fir weevil found associated with fir beetle in dying alpine fir. No control work in 1925.

Mammoth Camp. Numerous trees in this camp are in poor condition but there is no evidence that insects are the primary cause.

Rustic Insects. No damage by insects to rustic work was reported during 1926. The use of peeled logs in the building of new buildings appears to have stopped this particular damage.

RECOMMENDATIONS.

It is recommended that the following operations be conducted by the Park Service during the fall of 1926 and the spring of 1927.

(1) The trees for 150 feet on either side of the highway between West Yellowstone and the Madison River bridge be sprayed in June 1927. Cost about $3500.00

(2) The infested Douglas fir at Tower Falls and Camp Roosevelt be felled and barked, or burned before April 1, 1927. Cost $85.00 Possibly work can be done by giving infested trees to camp for fuel.

(3) The infested white bark pine at Dunraven Pass be felled and barked before May 1, 1927. Cost $10.00

(4) The infested lodgepole pine at Old Faithful Camp, Thumb Camp, Lake Camp, and Fishing Bidge Camp, be felled and barked or burned before June 1, 1927. Cost $190.00

(5) The infested lodgepole pine at Mud Volcanoes be felled and barked or burned before June 1, 1927. Cost $250.00

(6) The infested lodgepole pine, white bark pine, alpine fir, and Engelmann spruce at Cub Creek be felled and barked or burned by June 1, 1927. Cost $300.00

(7) The dying trees at Mammoth Camp be cut and used for fuel before June 1, 1927. This will prevent any possibility of secondary insects breeding up and attacking the remaining living trees which are not in very good condition. Cost $150.00

(8) The Douglas fir barkbeetle infestations in the budworm areas along the lower Yellowstone River and the infestations of the various barkbeetles in the forests of the Sylvan Pass country be watched closely for developments.

Yellowstone National Park, 1926. Plate 1.

A.- Egg masses of needletyer(Eulia sp.) on needles of lodgepole pine. Enlarged about 2 times.

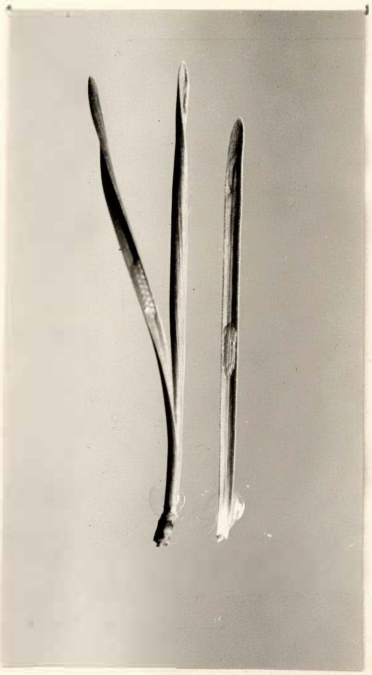
B.- Twig of lodgepole pine showing most of needles tied together by the work of the needletyer. Natural size.

C.- Section of lodgepole pine showing work of the Oregon engraver beetle(Ips oregoni Eich.) on the surface of the wood of the trunk of a dying tree. Longitudinal grooves are mines of the parent beetles. Smaller light colored areas are the pupal cells. About natural size.

D.- Section of dying lodgepole pine showing pupal cells of the smaller lodgepole pine bark weevil(Cylindrocopturus sp.) in the outer wood. About natural size.

Photographs by J. E. Patterson.

Yellowstone National Park, 1926. Plate 1.



A

B

C

D

Yellowstone National Park, 1926. Plate 2.

A.- Basal section of small lodgepole pine showing work of the lodgepole pine weevil(Pissodes murrayanae Hopk.). a, shredded covering of pupal cell. b,emergence holes of adult weevils through bark. c, pupal cells in outer wood. Natural size.

B.- Basal section of small lodgepole pine showing old work of the lodgepole pine weevil. Tree was attacked several years ago and was recovering from the injury when attacked again. Natural size.

C.- Chip of wood from the trunk of a dying alpine fir showing work of the alpine fir weevil(Pissodes burkei Hopk.). Larval mine terminates in a pupal cell excavated in the outer wood. Adult weevil in the pupal cell. Natural size.

D.- Section of bark from the trunk of a dying alpine fir showing work of the alpine fir bark weevil. Adult weevil is in cover of pupal cell gnawing its way out through the bark. Natural size.

Photographs by J. E. Patterson.

A

B

C

D